[35962]

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November 5, 2003

Certified Return Receipt
# 70020860000226092996

Ms. Kelly Meadows
Tetra Tech., Inc.
10306 Eaton Place, Ste. 340
Fairfax, VA 22030

Dear Ms. Meadows:

Dexter Cogen

Attached is the information requested recently by your letter received by Algonquin Power Windsor Locks, LLC.

If you have any further questions or concerns, please do not hesitate to contact me.

Sincerely,

James A. White
Plant Manager

JAW/dmt/algonword.doc.meadows

359G2 Intake
R1-CT-Dexter

# ENVIRONMENTAL RISK LIMITED

REPORT ON THE RESULTS
OF IMPINGEMENT AND ENTRAINMENT
MONITORING OF FISHES AND FISH LARVAE AT THE
DEXTER COGENERATION FACILITY
WINDSOR LOCKS, CONNECTICUT

Prepared For:

The Connecticut-Department of Environmental Protection
and
The Connecticut Siting Council

Prepared By:

David T. Turner

ERL Project No. 00601-C56-00

August, 1991

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## TABLE OF CONTENTS



## TABLES



## FIGURES



## APPENDICES

## 1.0 INTRODUCTION

This report addresses the impingement and entrainment of fish at the cogeneration facility built by the Dexter Corporation in Windsor Locks, Connecticut. The combined cycle cogeneration facility diverts water from the Windsor Locks Canal for cooling purposes in the plant and then returns the water to the Connecticut River. The Connecticut Department of Environmental Protection (CTDEP) has issued permits to the Dexter Corporation for the intake of water (DIV 89-31) and a National Pollutant Discharge Elimination System (NPDES) Permit to discharge water (CT 0026476).

The NPDES Permit states in paragraph.7, " On or before August 22, 1991, submit for the review and approval of the Commissioner a report detailing the results of impingement and entrainment monitoring in accordance with paragraph 5 [sic], a summary of the findings, a description of any remedial actions and a schedule for performing such remedial actions." Paragraph 6 of the permit (which refers to the scope of study for impingement and entrainment, and is the intended reference for paragraph 7) states "On or before February 22, 1990, submit for the review and approval of the Commissioner a scope of study report detailing impingement and entrainment monitoring of fish on the intake screens. (Submitted on January 17, 1990; revised on March 23, 1990; amended on April 11, 1990; approved on April 30, 1990)".

This report was completed in accordance with the approved scope of study, revision and addendum, and is being submitted for the review and approval of the Commissioner of the CTDEP. The postoperational studies for impingement and entrainment of fish were conducted by Environmental Risk Limited (ERL).

Postoperational monitoring was conducted using several different methods and included monitoring impingement at the intake structure, sampling in the Windsor Locks Canal for juvenile fish populations, and sampling at the discharge for larval fish and fish eggs. The data collected during these studies has been used to determine the types of fish affected and the magnitude of the effects of impingement and entrainment on fish populations in this area.

## 2.0 COGENERATION FACILITY

### 2.1 General Description

The Dexter Corporation Cogeneration Facility is a combined cycle cogeneration plant producing electricity and steam. The facility produces and sells electricity to Connecticut Light and Power Company and supplies steam and electricity to the Dexter Nonwovens Division's Mill. The plant consists of a gas turbine, a high pressure heat recovery boiler, a steam turbine, and two auxiliary boilers. The primary energy source is natural gas, with Number 2 fuel oil as a backup energy source when an adequate supply of natural gas is not available. The facility's maximum net electrical output is 56 Megawatts (MW).

The facility is located on property owned by Dexter in Windsor Locks, Connecticut to the south of the Dexter Nonwovens Division paper mill. The Windsor Locks Canal is to the west of the site and the Connecticut River is to the east. The site is approximately three acres at an elevation of approximately 30 to 40 feet above National Geodetic Vertical datum of 1929. The location of the facility is shown in the Site Location Map, Figure 2-1. The intake structure and discharge structure locations are shown in Figure 2-2, the Detail Site Plan.

The facility takes water from the Windsor Locks Canal for treatment and use as boiler makeup, once through cooling water, and steam injection during turbine firing. Boiler blowdown, demineralizer regeneration wastes, and drainage from chemical area floor drains are treated appropriately by neutralization and eventually discharged to the Connecticut River. Non-contact cooling water, used for the condensing turbine and for various components including pumps and compressors, is also discharged to the Connecticut River at temperatures of up to 110°F. Information on the thermal inputs expected from this discharge were submitted to the CTDEP as part of the 316(a) demonstration of the Clean Water Act. In addition, both the pre- and postoperational thermal studies of the Connecticut River have been submitted to the CTDEP which evaluate the impacts of the thermal discharge.

This facility uses an average of 15.61 million gallons per day (mmgd) and is permitted for a maximum cooling water discharge of 22.1 mmgd.

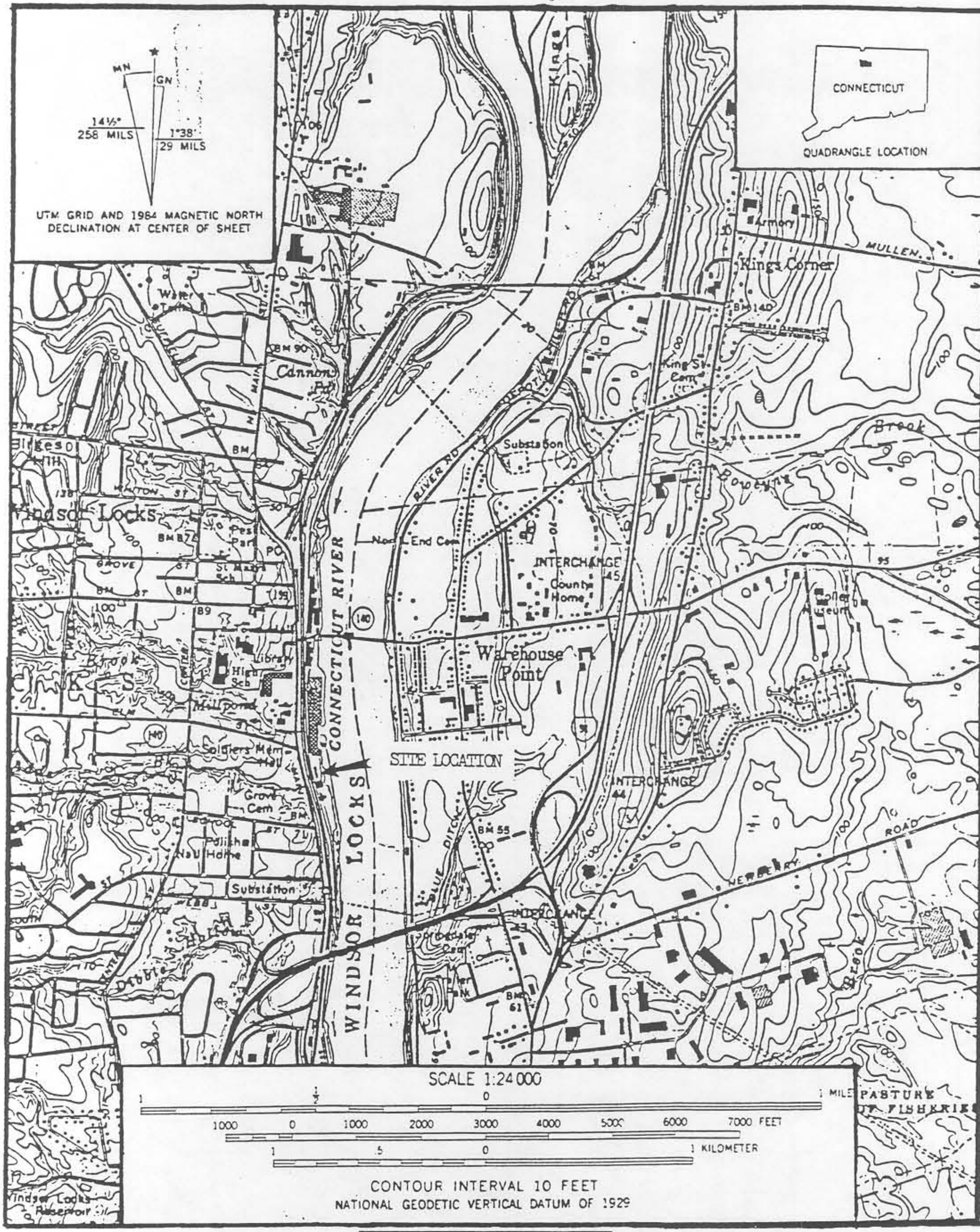


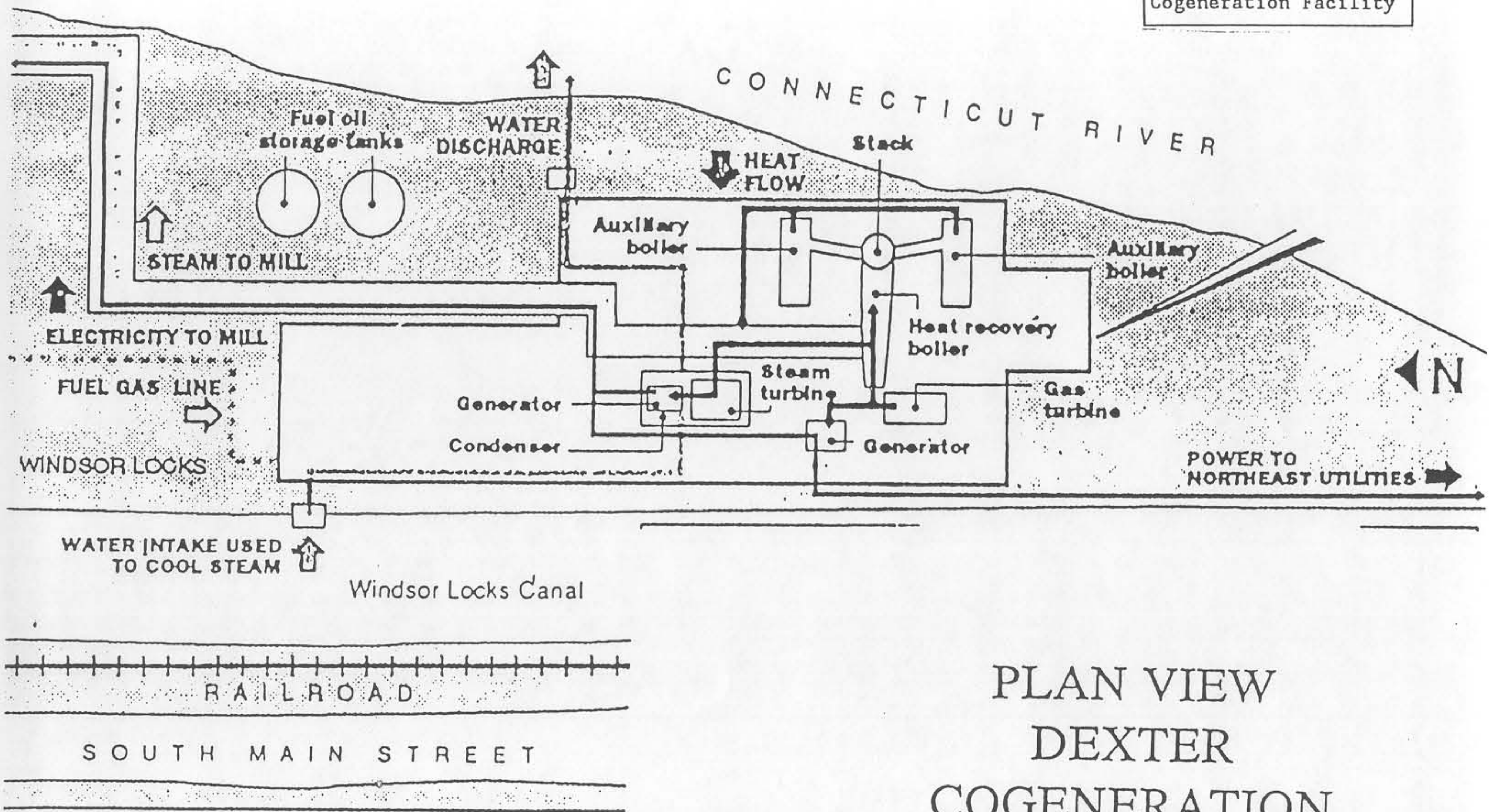

FIGURE 2-1

SITE LOCATION MAP

The Dexter Corporation

Cogeneration Facility

Figure 2-2
Detail Site Plan
The Dexter Corporation
Cogeneration Facility



Water use by the cogeneration facility can directly effect fish populations through the following two major processes: a) impingement of fish on the traveling screen at the cooling water intake structure and b) entrainment of larval fish and fish eggs which are small enough to pass through the travelling screen into the power plant cooling water system.

## 2.2 Intake Structure Description

The intake structure is constructed of reinforced concrete, with an eight foot vertical opening to the canal at an approximate elevation between 31 and 39 feet mean sea level (msl). The width of the structure is approximately six feet. Two different techniques are employed to prevent the intake of material (other than water) from the canal. The first method is the use of trash racks which have openings of approximately 6 inches square. Use of these racks prevents large debris (e.g., tree branches) from entering the intake structure. It is unlikely that any fish will be impinged on these trash racks due to the size of the openings.

The trash rack is equipped with a floating debris diverter which was installed after approval by the CTDEP on October 15, 1990. This diverter deflects floating debris away from the intake structure. A diagram of this diverter is shown in Figure 2-3. The debris diverter will be in place from April 1 through December 1 each year.

The second method used to prevent debris from entering the plant is a traveling vertical screen with a screen mesh opening size of 0.25 inches. This traveling screen is moved and rinsed as necessary to prevent the material caught on the screen from impeding water flow into the cooling system.

This screen is the location where fish as well as "trash"( i.e., debris small enough to pass through the trash racks) is captured. This screen is rinsed by a water spray directed opposite the direction of cooling water flow. All material from the screen is collected in a trough and collected in a trash basket.

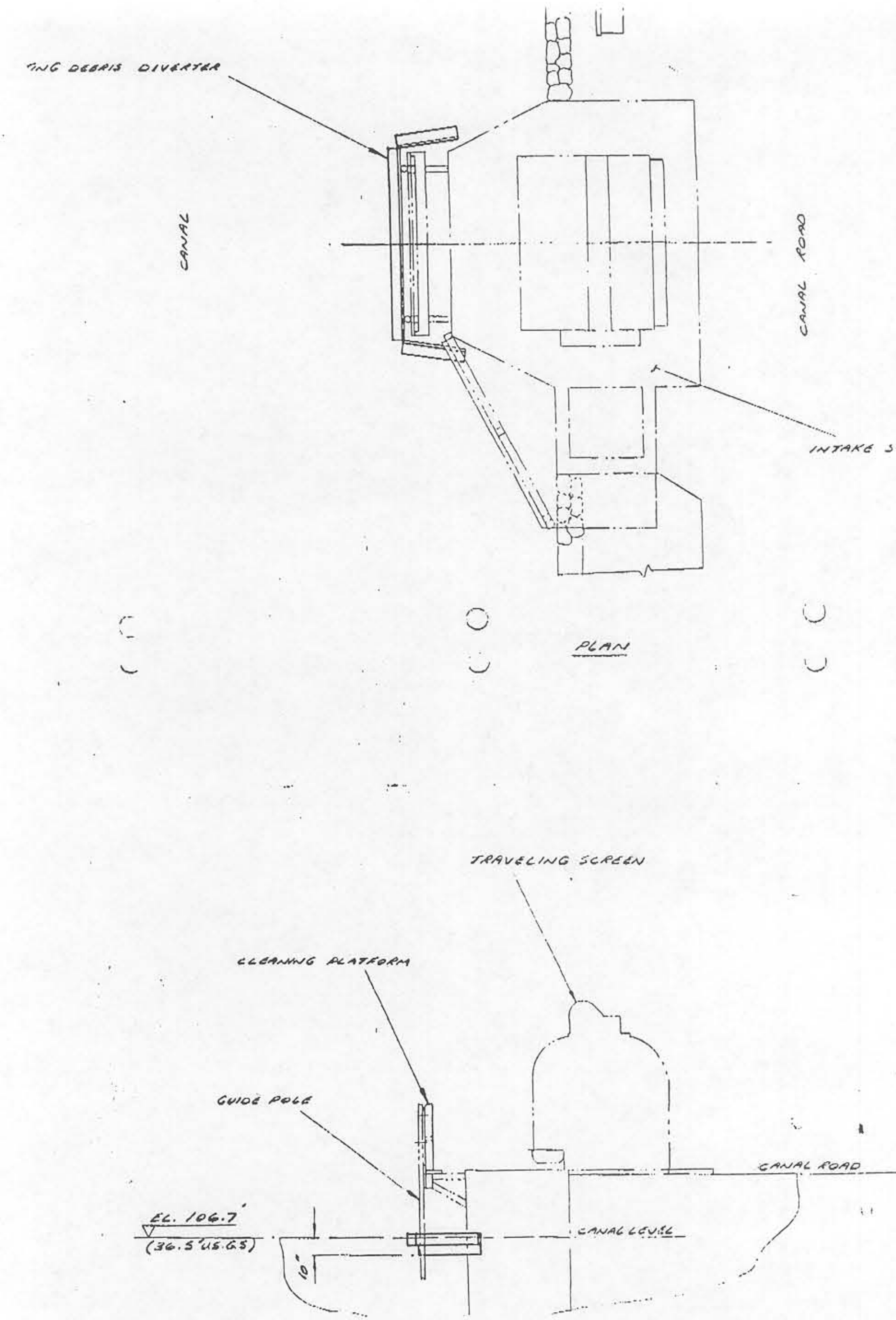



Figure 2-3
Drawing of Intake Structure
and Debris Diverter

## 3.0 WINDSOR LOCKS CANAL

The Windsor Locks Canal is approximately 5.3 miles long and runs parallel to the west bank of the Connecticut River through the towns of Suffield and Windsor Locks, Connecticut. The canal was constructed in 1827-29. The Dexter Cogeneration Facility is located just north of the canal locks at the southern end of the canal. Water is removed from the canal for use in the cogeneration facility and returned to the Connecticut River. The canal ranges from 44 to 160 feet in width, however, in most stretches the canal is approximately 80 feet wide. The width at the southern end of the canal is approximately 50 feet and the normal level of water is usually 9 to 10 feet deep. The annual average flow in the canal is approximately 600 cubic feet per second (cfs).

The head of the canal is at the Enfield Dam, a wing dam constructed in three parts. The original wing on the west bank was built at the time of canal construction, the east wing was built in 1849 and the dam connecting the wings was constructed in 1881. There are presently several breaches in this dam.

Based on an average flow of the Connecticut River of 16,350 cfs, the Windsor Locks Canal represents approximately 3.7% of the flow of the Connecticut River. The Dexter Cogeneration Facility will use a maximum of 34.2 cfs or approximately 5.7% of the average canal flow and approximately 0.2% of the average total flow of the Connecticut River.

## 4.0 POSTOPERATIONAL MONITORING

The postoperational monitoring was conducted using three independent methods. These include: impingement monitoring at the travelling screen, entrainment monitoring at the discharge, and fish utilization of the canal monitored in the Windsor Locks Canal just upstream of the cogeneration facility intake.

Data was collected during 1990 to access the actual impact of the cogeneration facility on fish populations. The three studies will be discussed separately.

## 5.0 ASSESSMENT OF EFFECTS OF IMPINGEMENT

### 5.1 Summary

Impingement monitoring consisted of collecting all fish trapped on the travelling screen at the cogeneration facility intake. The travelling screen rinses into a trough which empties into a trash basket adjacent to the intake structure. The trash basket was examined at 24 hour intervals and all material in the basket was sorted. Any fish in the basket were identified and measured.

The impingement monitoring commenced on April 1, 1990 and continued through December 15, 1990. Dexter personnel conducted the sampling each day. Once per week ERL personnel observed this sampling and verified the identification of the fish.

### 5.2 Impingement

#### 5.2.1 Monitoring at the Intake Screen

The intake structure, previously described in Section 2.2, includes both trash racks and a vertical traveling screen. The traveling screen is designed so that as the section of screening which is directly in the line of water flow accumulates material on it, the screen can be moved to prevent the reduction of water flow into the plant. Another section of screen replaces the partially clogged portion and any material caught on the screen is moved above the water intake and is rinsed by a pressurized water stream. The rinse water is directed by nozzles through the screen from the opposite direction of cooling water flow. This spray removes any material caught on the screen and directs it into a trough which empties into a trash basket where it is collected.

The trash basket is also constructed of 0.25 inch screening and retains all material rinsed from the traveling screen. Any impinged organisms are deposited in this basket. The trash basket is adjacent to the intake structure and extends below the canal water level. The trash which collects in the basket is submerged below the normal water level.

The basket was emptied a minimum of once per day and the material collected was examined for fish. Fish were identified to the lowest possible taxonomic level and measured. The primary reference used to identify the fish was "Freshwater Fishes of Connecticut" 1988. Walter R. Whitworth. Bulletin 101, State Geological and Natural History Survey of Connecticut, Department of Environmental Protection. The facility kept daily logs of the fish found in the trash basket including identification and total length.

The original schedule for monitoring of impingement at the intake screen from April 1 through October 30. During the associated study on fish utilization of the Windsor Locks Canal, it was determined that juvenile clupeids were present in the canal through November, therefore, impingement sampling at the intake was extended until December 13, 1990.

### 5.2.2 Results of Impingement Monitoring

As stated previously, the trash basket was examined at least once per day of operation from April 1, 1990 through December 13, 1990. During this period of study, 209 fish were captured during the 255 operating days of this study period. The fish were identified and the size of the fish recorded.

The results of impingement monitoring are summarized in Table 5-1. The daily fish impingement, identifications, and mean sizes are included in Appendix A.

The fish catches were compared to the average daily flow rates for the facility. This flow data for the cooling water discharge is presented in Appendix B. The relationship between flow rate and impingement rate was examined. When examined on a monthly basis the number of fish captured generally increased with the flow rate. The month with the highest flow rate, August, is also the month with the highest impingement, 122 fish.

These factors appear to be related, however, there is a very low correlation between the two variables (0.57 correlation coefficient using the least squares analysis).

Table 5-1
Results of Impingement Sampling
at the Dexter Cogeneration Facility

| SPECIES / MONTH | Apr. | May | June | July | Aug. | Sept. | Oct. | Nov. | Dec. | TOTAL |
|---|---|---|---|---|---|---|---|---|---|---|
| American Shad (*Alosa sapidissima*) | | | 5 | 5 | 59 | 6 | | 5 | | 80 |
| Blueback Herring (*Alosa Aestivalis*) | | | 4 | 2 | 7 | 7 | 5 | 6 | 1 | 26 |
| Bluegill (*Lepomis macrochirus*) | 4 | 5 | 2 | 5 | 4 | 9 | 3 | 1 | 1 | 34 |
| Pumpkinseed (*Lepomis gibbosus*) | | | | | 3 | | | | | 3 |
| White Catfish (*Ictalurus catus*) | 1 | | 1 | | 10 | | 1 | | | 13 |
| Smallmouth Bass (*Micropterus dolomieui*) | 2 | | | 37 | 6 | 2 | | | | 47 |
| Smelt (*Osmerus eperlanus*) | 1 | | | | | | | | | 1 |
| Crappie (*Pomoxis annularis*) | | | | | 2 | | | | | 2 |
| Spottail Shiner (*Notropis hudsonius*) | | | | | | | 1 | 1 | | 2 |
| White Sucker (*Catostomus commersoni*) | | | | | | | 1 | | | 1 |
| TOTALS | 7 | 6 | 12 | 12 | 122 | 22 | 13 | 13 | 2 | 209 |

Numbers don't add up!

The higher flow rate corresponds with the season of greatest fish abundance in the canal. This is due to the seasonal use of the canal by emigrating clupeid fish. The largest impingement events that occurred involved the capture of juvenile clupeids from August 25 through August 31, 1990. This period was also the period of the highest demand for cooling water by the cogeneration facility

There were no large impingement events (i.e., greater than 100 fish) during 1990. (The largest impingement event was on August 31, 1990 when 17 clupeids were impinged).

## 6.0 MONITORING IN THE CANAL

In addition to the daily examination of the trash basket for impinged fish, the Windsor Locks Canal was also sampled to assess use of the area in the vicinity of the intake structure by fish. This sampling was initiated to help determine the extent of local fish populations and canal utilization by juvenile clupeids using the canal for emigration.

Seining was done at one station on the canal, approximately 1,000 feet north (upstream) of the intake, and was conducted approximately once every 14 days from July 19 to November 21.

### 6.1 Seining Methods

The seining in the canal was performed by initially setting two blocking seines across the canal approximately 50 feet apart. These seines were both set perpendicular to canal flow. The seines were approximately 50 feet long and 10 feet high. All nets were constructed from one-quarter-inch (0.25 in) nylon mesh and were equipped with floats and weights (two to three weights per foot).

These blocking seines had additional weight added in the fall when canal water flow levels were higher and there were many leaves in the canal. Many of the leaves were trapped by the seine and this, in conjunction with the higher water levels and flow rates, caused the weight line of the seine to be lifted from the canal bottom. This was overcome by adding lengths of chain to the weight line of the blocking seines.

These blocking seines were usually set from above the canal by suspending the net over the canal and lowering the nets into position in the canal from above. (In some instances the blocking seines were heavily weighted with chains, in these cases the blocking seine was anchored on one side of the canal and drawn across through the water (i.e., set from one side).

The following method was used to deploy and retrieve the nets in the canal. The blocking seines were each suspended over the canal in the respective positions by two workers on each side of the canal. Before being set, the nets were readied by extending them across the bridge located directly upstream from the sampling location. The nets were then carried, while extended over the canal, to their respective positions. These blocking seines were then lowered into position into the canal and anchored on the canal bank. The upstream blocking net was placed into position first, followed immediately by the downstream blocking net.

Lines were positioned hanging across the canal and used to draw the catch seine across the canal through the area enclosed by the blocking seines. The enclosed area was sampled by drawing a 60-foot seine (catch seine) across the canal (parallel to canal flow). The catch seine was hauled a minimum of two times per sampling event. The net was always drawn across the canal from west to east.

Due to the steep sides of the canal, and lack of an adequate beach, the catch seine was equipped with several lines attached to the weight line. These lines were used to aid in pulling up the weight line of the seine without loss of the captured fish.

This method effectively blocked off a section of canal and allowed seining of the enclosed area with minimal losses of fish from that area. The method also allowed the examination of an approximate cross-section of the canal and is believed to provide a representative sample of the fish utilizing this area of the canal during the study period.

Fish collected by seining were immediately transferred to buckets containing water from the canal. Fish were measured, identified and counted. After identification, fish in good condition were released back into the Windsor Locks Canal, downstream of the cogeneration facility intake. This included the species considered to be year round residents in the canal. Typically, the migrant, anadromous fish caught in the seining procedure were mortally injured in the course of capture and handling.

## 6.2 Results of Canal Sampling

The data for the fish collected during the canal sampling is shown in Table 6-1. The sampling of fish in the canal was initiated mainly to determine the number of anadromous fish, notably clupeids, using the canal for emigration and to determine the types and numbers of resident (non-migrant) fish in the canal.

The results of the measurements of the fish captured during this phase of the study are included in Table 6-2.

This study provides data for the comparison of types of fish present in the canal to the data on fish impinged by the cogeneration facility intake structure. The non-migrant fish captured in the canal give an indication of the native fish populations utilizing the canal.

The results indicate several species of fish that appear to be either residents (i.e., not migrating) in the Windsor Locks Canal or using the canal as a nursery area. In addition, there are clupeid larvae emigrating through the canal (blueback herring and American shad) through the summer and into the fall. During the period of study, there were no endangered species or species of special concern captured.

This data on fish utilization of the Windsor Locks Canal was compared to the data collected for impingement at the cogeneration facility intake. The comparison of fish present in the canal and fish impinged at the intake is to determine the effect of impingement on the populations present and to determine if the numbers of fish present effected the impingement rate.

There is not a distinct correlation between the numbers of clupeids observed in the canal and the number impinged at the cogeneration facility intake structure. This was most evident from comparison of the data of fish impingement during August and October, 1990.

During the month of August, 66 juvenile clupeids were impinged at the cogeneration facility, however, there were only 5 juvenile clupeids

Table 6–1
Results of Canal Sampling

| | DATE | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 7–19 | 8–2 | 8–23 | 8–30 | 9–6 | 9–13 | 9–28 | 10–11 | 10–25 | 11–08 | 11–21 |
| **Family:** Clupeidae | | | | | | | | | | | |
| Alosa aestivalis | 3 | 2 | – | – | 25 | – | – | 25 | 43 | – | – |
| A. sapidissima | 14 | 3 | – | – | – | – | – | 50 | 76 | 25 | – |
| **Family:** Cyprinidae | | | | | | | | | | | |
| Notropis hudsonius | 4 | – | – | – | – | – | – | – | – | – | – |
| **Family:** Centrarchidae | | | | | | | | | | | |
| Lepomis cyanellus | 3 | 13 | 5 | 11 | 8 | 4 | 6 | – | 3 | – | – |
| L. gibbosus | – | – | 2 | – | – | – | – | – | – | – | – |
| L. macrochirus | 6 | 20 | 8 | 28 | 2 | 2 | – | 1 | – | – | – |
| Micropterus dolomieui | 13 | 18 | 11 | 17 | 4 | 10 | 1 | 3 | 1 | – | – |
| Pomoxis nigromaculatus | 13 | 38 | 6 | 2 | 1 | – | – | – | – | – | 1 |
| **Family:** Percidae | | | | | | | | | | | |
| Etheostoma olmstedi | – | – | – | 1 | – | – | 2 | 1 | – | – | 2 |

| Minimum, Maximum and Average Lengths In Centimeters | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| DATE | 7–19 | | | 8–2 | | | 8–23 | | | 8–30 | | | 9–6 | | | 9–13 | | | 9–28 | | | 10–11 | | | 10–25 | | | 11–08 | | | 11–21 | | |
| | Min. | Max. | Avg. | Min. | Max. | Avg. | Min. | Max. | Avg. | Min. | Max. | Avg. | Min. | Max. | Avg. | Min. | Max. | Avg. | Min. | Max. | Avg. | Min. | Max. | Avg. | Min. | Max. | Avg. | Min. | Max. | Avg. | Min. | Max. | Avg. |
| Family: Clupeidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Alosa aestivalis | 2.9 | 3.3 | 3.1 | 3.3 | 3.4 | 3.35 | - | - | - | - | - | - | 4.9 | 5.5 | 5.2 | - | - | - | - | - | - | 5.4 | 8.0 | 6.5 | 5.3 | 8.6 | 6.3 | - | - | - | - | - | - |
| A. sapidissima | 3.2 | 6.2 | 4.9 | 2.9 | 3.8 | 3.2 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 5.2 | 8.6 | 7.1 | 5.0 | 10.1 | 6.8 | 5.4 | 8.6 | 6.3 | - | - | - |
| Family: Cyprinidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Notropis hudsonius | 2.9 | 3.5 | 3.1 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 7.3 | 7.3 | 7.3 | - | - | - | - | - | - |
| Family: Centrarchidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Lepomis species | 4.7 | 4.8 | 4.8 | 1.9 | 4.8 | 2.5 | 2.5 | 3.6 | 3.2 | 2.2 | 4.0 | 3.5 | 2.4 | 3.9 | 3.5 | 3.3 | 4.1 | 3.7 | 3.3 | 3.9 | 3.7 | - | - | - | 3.0 | 5.0 | 3.9 | - | - | - | - | - | - |
| L. gibbosus | - | - | - | - | - | - | 7.4 | 15.0 | 11.7 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| L. macrochirus | 5.2 | 5.8 | 5.4 | 5.1 | 13.3 | 6.3 | 7.4 | 16.0 | 11.7 | 5.9 | 18.0 | 6.1 | 13.4 | 13.9 | 13.7 | 14.9 | 15.8 | 15.4 | - | - | - | 14.5 | 14.5 | 14.5 | - | - | - | - | - | - | - | - | - |
| Micropterus dolomieui | 3.1 | 4.6 | 3.7 | 4.1 | 11.2 | 6.2 | 4.4 | 7.6 | 6.1 | 4.8 | 24.7 | 10.5 | 3.6 | 9.2 | 6.6 | 5.2 | 19.5 | 9.8 | 5.5 | 5.5 | 5.5 | 5.9 | 20.2 | 10.9 | 7.9 | 7.9 | 7.9 | - | - | - | - | - | - |
| Pomoxis nigromaculatus | 1.8 | 3.3 | 2.4 | 2.3 | 16.0 | 3.4 | 3.2 | 4.9 | 4.0 | 3.8 | 4.1 | 4.0 | 3.5 | 3.5 | 3.5 | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | 4.6 | 4.6 | 4.6 |
| Family: Percidae | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
| Etheostoma olmstedi | - | - | - | - | - | - | - | - | - | 7.0 | 7.0 | 7.0 | - | - | - | - | - | - | 4.7 | 5.7 | 5.2 | 6.7 | 6.7 | 6.7 | - | - | - | - | - | - | 5.7 | 6.7 | 6.2 |

Table 6-2

Measurement of Fish
Captured in Canal Sampling

captured in the two samplings of the canal. Alternatively, in October, a greater number of clupeids were found in two samplings of the canal, 143, however, only 5 were impinged.

This may be caused by the fish holding in the canal during certain periods and moving during other periods. This indicates the number of fish found in this area of the canal is not directly effecting the impingement rate.

The data collected by sampling fish in the canal provide several useful pieces of information. There are several species of fish which utilize the Windsor Locks Canal. Juvenile clupeids (both American shad and blueback herring) utilize the canal for downstream migration (emigration).

The juvenile clupeids were found in the canal from June through December. There is a strong possibility that these juvenile fish are either using the canal as a nursery area or holding in the canal due to slightly higher temperatures of this waterbody (or due to a lack of suitable downstream exit). This study was not able to, nor was it intended to, distinguish between populations of clupeids that are temporarily holding in the canal or emigrating.

There are several fish species that were captured during this sampling that appear to have resident populations in the canal. Several species in the Centrarchidae Family were captured in this sampling effort including both adults and juveniles. Two species of sunfish including Lepomis gibbosus (pumpkinseed) and L. macrochirus (bluegill), as well as Micropterus dolomieui (smallmouth bass). In addition, juvenile Pomoxis nigromaculatus (crappie) were also captured.

Fish from two other families were also captured. These include Etheostoma olmstedi (tessellated darter) in the Percidae family and Nototropis hudsonius (spottail shiner) in the Cyprinidae family.

Due to the lack of field identification characteristics, juvenile Lepomis, those less than 5.0 centimeters (cm) were identified only to the genus level.

The fish captured in the canal and low impingement rates at the cogeneration facility indicate only a minimal impact from the cogeneration facility intake on fish typically found in the canal during the sampling period. This includes both the clupeids and native fish that utilize this area.

## 7.0 ENTRAINMENT

### 7.1 Monitoring

Entrainment rates were determined by sampling at the cooling water discharge using a conical plankton net. The net used was a custom made net approximately 1.0 meter (m) long and 0.3 m wide at the open end. The net was constructed of Nitex screening with a mesh size of 250 micrometers (um). The net was equipped with a plastic straining bucket at its' closed end, also containing 250 um Nitex screening.

The amount of water sampled was measured with a propeller style flowmeter fixed in the open end of the net. The flow meter was equipped with a counter which was used to calculate volume of water which had passed through the net. The counter was calibrated to establish the relationship between flowmeter counts and water volume.

The nets were set directly at the end of the cooling water discharge pipe on the Connecticut River. (This was due to a lack of space at the intake structure necessary to set up nets.) This was accomplished by attaching the net to a length of pipe driven down into the river bed directly at the end of the discharge pipe. The net was positioned directly in the cooling water discharge by attaching the net to the pipe and lowering the net into the discharge. The period of time the net was left in place in front of the discharge, or the "set", ranged from 10 to 30 minutes. The number of "sets" done on a sampling day varied from one to fourteen with an average total sampling time of 1.5 hours. The cooling water discharge was sampled on 9 occasions from May through July.

For each entrainment sample taken, the net was "set" in the cooling water discharge for a predetermined period. At the end of this period, the net was removed from the water and the straining bucket was removed and emptied. The flowmeter count was recorded and the next "set" initiated.

All material caught in the strainer was sorted for fish eggs and larvae. The fish eggs and larvae were removed and preserved. Samples were initially persevered in 10% neutral buffered formalin for a minimum of seven days and then transferred to a 70% ethanol solution.

The specimens collected were identified later in the laboratory. Fish eggs and larvae were identified to the lowest taxonomic level possible.

### 7.2 Results

A summary of the entrainment monitoring is presented in Table 7.1. The identifications of the organisms captured are included in Table 7-2 which also includes the number and species of fish eggs and larvae captured in the entrainment monitoring.

The most abundant eggs entrained were identified as Alosa species. These eggs represented 87% of the eggs entrained. This also represented the most abundant species of fry entrained with 93% of fry captured identified as Alosa.

The eggs and larvae of different Alosa species are very similar therefore the identifications were only carried out to the genus level.

Estimates of the total entrainment impact were made from the average number of fish captured per million gallons of water sampled, and the total volume of water discharged from May 1 through July 31, 1990 (the period eggs and larvae would be expected).

The cooling water flow rate and the flowmeter readings (volume) per sample period were used to calculate sample efficiency. The total volume of cooling water is known as is the volume of water actually sampled by the plankton net. Based on the flows, the net would sample an average approximately 18% of the cooling water flow from the discharge pipe during the sampling.

Using the period from May 1 through July 31 as the critical period for entrainment, the total volume of water used by the facility during this period equals 1,231.47 million gallons. (The cooling water flows for the

Table 7-1

Summary of Entrainment Monitoring

| DATE | # EGGS | # LARVAE | VOLUME SAMPLED Gallons | TOTAL FLOW FOR DAY MGD * |
|---|---|---|---|---|
| May 3 | 5 | - | 95,000 | 12.73 |
| May 10 | 8 | 1 | 206,500 | 13.77 |
| May 21 | 232 | 1 | 93,400 | 12.45 |
| May 31 | 5 | - | 201,600 | 13.44 |
| June 7 | 3 | - | 180,150 | 12.01 |
| June 11 | 91 | - | 130,840 | 11.63 |
| June 20 | 12 | 4 | 206,550 | 13.77 |
| June 28 | 4 | 11 | 174,200 | 17.42 |
| TOTALS | 360 | 18 | 1,288,240 | 107.22 |

* MGD is Millions of Gallons per Day

Table 7-2

Results of Entrainment Sampling: Eggs

| DATES: | 5/3 | 5/10 | 5/21 | 5/31 | 6/7 | 6/11 | 6/20 | 6/28 |
|---|---|---|---|---|---|---|---|---|
| _Alosa_ species | - | 1 | 232 | 5 | 3 | 85 | 10 | - |
| _Notropis_ species | 3 | 7 | | | | 6 | 2 | 4 |
| _Cyprinus_ | 1 | | | | | | | |
| Unidentified | 1 | | | | | | | |

| | | |
|---|---|---|
| TOTALS | _Alosa_ | 336 |
| | _Notropis_ | 22 |
| | _Cyprinus_ | 1 |
| | Unidentified | 1 |
| | | 360 |

Results of Entrainment Sampling: Larvae

| DATES: | 5/3 | 5/10 | 5/21 | 5/31 | 6/7 | 6/11 | 6/20 | 6/28 |
|---|---|---|---|---|---|---|---|---|
| _Alosa_ species | - | - | 1 | - | - | 1 | 4 | 11 |
| _Notropis_ species | - | 1 | - | - | - | - | - | - |

| | | |
|---|---|---|
| TOTALS | _Alosa_ | 17 |
| | _Notropis_ | 1 |
| | | 18 |

cogeneration facility are included included in Appendix B.) The number of eggs collected during entrainment sampling totaled 360. The entrainment rate per million gallons of water used was calculated using the number of eggs divided by the volume of water sampled (1,288,240 gallons). The entrainment rate calculated from this data is 280 eggs per million gallons of water.

The entrainment rate for fry was calculated by the same method. The total number of fry collected during the entrainment sampling was 18, therefore, the entrainment for fry would be estimated at 14 fry per million gallons of water.

By projecting the entrainment rate to the total volume of water used during the critical entrainment period, the total entrainment of all species is estimated to be 344,812 eggs and 17,240 fry. The estimated total entrainment for the individual species are presented in Table 7.3

TABLE 7-3

Estimates of Yearly Entrainment of Eggs by Species

| SPECIES | |
|---|---|
| _Alosa_ | 321,710 |
| _Notropis_ | 21,034 |
| _Other_ | 2,068 |
| TOTAL | 344,812 |

Estimate of Yearly Entrainment of Larvae by Species

| SPECIES | |
|---|---|
| _Alosa_ | 16,282 |
| _Notropis_ | 958 |
| TOTAL | 17,240 |

# 8.0 DISCUSSION

## 8.1 Impingement

### 8.1.1 Effects of Impingement on Fish Populations

The study of impingement of fish at the Dexter Cogeneration Facility included 255 days of sampling during which a total of 209 fish were captured by the travelling screen.

Approximately 49% of the fish captured were juvenile clupeids including both blueback herring and American shad. These juvenile clupeids are either using the canal for emigration, or accidently misdirected into the canal during emigration from the river.

The remainder of the fish captured (with the exception of the one rainbow smelt) were fish that appear to have "local" populations in the canal. These include the bluegill, pumpkinseed, white catfish, smallmouth bass, crappie, spottail shiner and white sucker.

The total number of fish captured is relatively small. In addition, the majority of the fish were juveniles or immature. The effect of impingement on the fish populations involved would therefore be considered minimal.

There were several small impingement events (i.e., greater than 10 fish captured in a single day) during the period of the highest cooling water flows. These events were associated with large amounts of floating debris, usually floating eelgrass mats, that were caught by the trash racks in front of the intake structure.

It is believed that these floating debris mats were attracting fish since the canal has limited natural cover in this general area. Since the mats were held in front of the intake structure by the water flow into the facility, it is postulated that fish using the mat as cover were therefore more closely exposed to the intake.

The problem with debris mats accumulating near the intake was ameliorated somewhat by the addition of a floating debris diverter at the intake structure in October of 1990. This debris diverter was designed to direct floating debris away from the trash rack and use the water current in the canal to move the debris downstream past the intake structure. This has helped alleviate the problem but has not eliminated it.

A further modification to the debris diverter is being considered that will use water jets (from the travelling screen rinse pumps) to create surface currents that keep floating debris further away from the intake structure. The complete plans for the proposed modification to the debris diverter will be submitted to the CTDEP in September, 1991 for approval.

This proposed modification to the intake is to reduce the potential for large impingement events at the cogeneration facility.

### 8.1.2 Further Monitoring

To access the continued impact of impingement of fish at the Dexter Cogeneration Facility, the impingement monitoring will continue from April 1 through November 30 on a daily basis in 1991. Any large impingement events (i.e., greater than 100 fish per day) will be immediately reported to the CTDEP. A report which summarizes the second year of impingement monitoring will be submitted to the CTDEP after completion of the data collection. The need for any continued monitoring will be reviewed in this second operational year report.

## 8.2 Fish Utilization in the Windsor Locks Canal

The results of the sampling for fish in the Windsor Locks Canal demonstrate three important points. These include identification of local populations, use of the canal by emigrating clupeids, and data on the relative abundance of fish for comparison to impingement data.

The local populations of fish utilizing the canal were reported in Section 6.2 of this report.

The juvenile clupeid fish found in both the canal sampling and those impinged at the intake structure indicate the Windsor Locks Canal is used by these fish for emigration. The extent of clupeids using the canal for emigration can not be determined from the data collected in this study.

Examination of the data on relative abundance of fish indicate that both the local fish populations and juvenile clupeids utilize the Windsor Locks Canal in the area of the cooling water intake. In addition, most of the species of the fish identified during the canal utilization sampling were also found in the impingement monitoring at the intake structure. However, the relative abundance of fish in the canal did not correlate with the fish impingement at the cogeneration facility.

The sampling of fish in the canal has provided some important information as described previously. However, limited if any further information can be gained by additional monitoring in the canal. No further sampling in the canal is proposed. The ultimate impact on the fish in the canal is from impingement and this will be monitored further at the intake structure.

## 8.3 Entrainment

One of the major concerns of the entrainment of fish eggs and larvae through the use of cooling water in the Connecticut River in this area is due to the anadromous fish which reproduce upstream of the intake of the Windsor Locks Canal. The presence of anadromous fish in the Connecticut River has been thoroughly discussed in the literature. One of the major fisheries of concern is fish in the family Clupeidae. This is due to its' relatively large size and the location of reproductive areas in the Connecticut River upstream of the head of the Windsor Locks Canal which is the source of cooling water for the cogeneration facility.

Both American shad and blueback herring have been captured in the impingement and canal sampling at the Dexter Cogeneration Facility. In addition, the majority of fish eggs and larvae captured in the entrainment study were also clupeids.

Two other species which were of special interest are the shortnose and Atlantic sturgeons. These species are believed to have small populations in the Connecticut River and reproduce in areas upstream of the head of the Windsor Locks Canal. This would signify both eggs and larvae could be entrained in the cooling water of the Dexter Cogeneration Facility. Neither eggs nor larvae of either sturgeon species were detected in the entrainment sampling conducted.

The results of the entrainment monitoring at the Dexter Cogeneration Facility indicate that there are fish eggs and larvae present in the Windsor Locks Canal which are subsequently entrained through the cooling water system. The total number of eggs of all species entrained is estimated to be approximately 350,000 over a three month period from May 1 through July 31.

Although the number of eggs estimated to be entrained is a large number, the ultimate effect of a loss of 350,000 eggs to the fish populations affected is not the direct loss of 350,000 adult individuals.

The number of eggs laid by an adult fish is typically large, an example would be the estimated 269,000 eggs laid by an adult American shad in the Connecticut River (Jones et al, 1978). In addition, the survival from egg to larvae is typically only a fraction of the number of eggs laid. In previous studies on the Connecticut River (Northeast Utilities Services Company, 1976) a 10% survival rate from egg to larvae was assumed.

Therefore, the loss of 350,000 eggs would ultimately mean the loss of 35,000 larvae. This is obviously much less of an impact than the loss of 350,000 adults would be on the population. Although it is recognized that larval and juvenile fish do have important ecological value, the loss of 35,000 larvae would again not represent the loss of this many juveniles or adults. There is also a reduction in the number of larvae that survive to become juvenile fish as well as a loss from juvenile to adult stages.

In previous studies done on anadromous fish populations in the Connecticut River, survival from egg to adult has been estimated from

0.001% (Leggett, 1969) to 0.0014% (Kissil, 1974). Using the lower of these estimates (0.001%), the entrainment of 350,000 eggs (assuming these were all shad eggs) would represent the loss of approximately 3.5 adults.

Therefore, although the estimate of the number of eggs entrained by the cooling water system is a large number, this number of eggs ultimately represents the loss of only a very few adult individuals from the clupeid populations in the Connecticut River.

Based on the ultimate loss of this small number of adults, the losses due to entrainment of both eggs and larvae have only a minimal impact on the clupeid fish populations in the Connecticut River.

Other species are probably also influenced by entrainment. It is speculated that due to to smaller numbers of eggs and larvae produced by other species in comparison to the clupeids, these other species were not collected during the sampling effort. The impact on these other species is believed to be proportionately as small as that on clupeid populations.

It is concluded that although there is a very small affect on fish populations due to entrainment, the affects will not be deleterious to the populations of fish involved. No further entrainment monitoring is proposed.

## 9.0 CONCLUSIONS

The results of the three phases of postoperational monitoring of impingement and entrainment of fish at the Dexter Cogeneration Facility demonstrate that the total loss of fish from the operation of this facility including both impingement and entrainment losses are very small. It is concluded that there will be no detrimental effects to any fish populations resulting from the operation of the cooling water use at this cogeneration facility regarding either impingement or entrainment losses.

To continue to access the effects of impingement, the results of fish impingement monitoring during 1991 will be reported. This is important to assess the potential impact due to a modification made in October 1990 to the intake structure consisting of the addition of a debris diverter. No further monitoring is proposed for either fish utilization in the Windsor Locks Canal or for entrainment.

This study was completed in accordance with the approved scope of study, revision and addendum, and is being submitted for the review and approval of the Commissioner of the CTDEP to fulfill the requirements of Paragraph 7 of the NPDES permit for the Dexter Cogeneration facility.

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APPENDIX A

Fish Impingement at Intake Structure

# FISH IMPINGEMENT

| DATE | NAME | NUMBER | SIZE (Inches) |
|---|---|---|---|
| 05-Apr-90 | Bluegill | 1 | 4.00 |
| 05-Apr-90 | White Catfish | 1 | 3.50 |
| 08-Apr-90 | Bluegill | 1 | 3.00 |
| 13-Apr-90 | Smallmouth Bass | 1 | 1.50 |
| 18-Apr-90 | Smallmouth Bass | 1 | 3.00 |
| 25-Apr-90 | Bluegill | 1 | 3.50 |
| 26-Apr-90 | Bluegill | 1 | 1.25 |
| 01-May-90 | Bluegill | 1 | 5.00 |
| 09-May-90 | Bluegill | 1 | 3.00 |
| 09-May-90 | Rainbow Smelt | 1 | 3.00 |
| 11-May-90 | Bluegill | 1 | 0.50 |
| 11-May-90 | Bluegill | 1 | 1.00 |
| 16-May-90 | Bluegill | 1 | 1.00 |
| 15-Jun-90 | Blueback Herring | 1 | 9.00 |
| 18-Jun-90 | American Shad | 1 | 8.00 |
| 18-Jun-90 | Bluegill | 1 | 1.00 |
| 18-Jun-90 | Blueback Herring | 1 | 11.00 |
| 21-Jun-90 | Blueback Herring | 1 | 10.00 |
| 22-Jun-90 | Blueback Herring | 1 | 9.00 |
| 23-Jun-90 | Bluegill | 1 | 4.00 |
| 24-Jun-90 | American Shad | 1 | 19.00 |
| 27-Jun-90 | White Catfish | 1 | 3.00 |
| 30-Jun-90 | American Shad | 2 | 9.00 |
| 30-Jun-90 | American Shad | 1 | 15.00 |
| 01-Jul-90 | American Shad | 1 | 9.00 |
| 20-Jul-90 | Bluegill | 1 | 1.00 |
| 20-Jul-90 | American Shad | 1 | 1.00 |
| 20-Jul-90 | American Shad | 1 | 1.00 |
| 23-Jul-90 | American Shad | 1 | 2.00 |
| 24-Jul-90 | American Shad | 1 | 1.00 |
| 26-Jul-90 | Blueback Herring | 2 | 2.00 |
| 27-Jul-90 | Bluegill | 1 | 1.50 |
| 28-Jul-90 | Bluegill | 1 | 3.00 |
| 28-Jul-90 | Bluegill | 1 | 1.00 |
| 28-Jul-90 | Bluegill | 1 | 1.50 |
| 01-Aug-90 | Bluegill | 1 | 1.00 |
| 02-Aug-90 | American Shad | 1 | 0.50 |
| 02-Aug-90 | American Shad | 1 | 1.00 |
| 06-Aug-90 | Pumpkinseed | 1 | 4.00 |
| 06-Aug-90 | Pumpkinseed | 1 | 5.00 |
| 06-Aug-90 | Pumpkinseed | 1 | 3.00 |
| 08-Aug-90 | Blueback Herring | 5 | 1.00 |
| 08-Aug-90 | White Catfish | 1 | 10.00 |
| 08-Aug-90 | Bluegill | 1 | 1.00 |
| 12-Aug-90 | Bluegill | 1 | 5.00 |
| 19-Aug-90 | Blueback Herring | 1 | 1.00 |
| 20-Aug-90 | Blueback Herring | 1 | 1.00 |
| 23-Aug-90 | American Shad | 1 | 1.00 |
| 24-Aug-90 | American Shad | 1 | 1.00 |
| 24-Aug-90 | American Shad | 1 | 1.50 |
| 24-Aug-90 | American Shad | 1 | 2.00 |
| 24-Aug-90 | Bluegill | 1 | 1.00 |

| DATE | NAME | NUMBER | SIZE (Inches) |
|---|---|---|---|
| 24-Aug-90 | White Catfish | 5 | 2.00 |
| 25-Aug-90 | Smallmouth Bass | 12 | 2.00 |
| 25-Aug-90 | American Shad | 3 | 2.00 |
| 26-Aug-90 | Catfish | 2 | 2.00 |
| 26-Aug-90 | American Shad | 4 | 3.00 |
| 26-Aug-90 | Smallmouth Bass | 8 | 1.50 |
| 27-Aug-90 | Smallmouth Bass | 8 | 1.50 |
| 27-Aug-90 | American Shad | 7 | 2.50 |
| 28-Aug-90 | Smallmouth Bass | 7 | 3.00 |
| 28-Aug-90 | American Shad | 3 | 3.00 |
| 29-Aug-90 | American Shad | 11 | 2.00 |
| 30-Aug-90 | American Shad | 8 | 3.00 |
| 30-Aug-90 | Smallmouth Bass | 2 | 1.50 |
| 30-Aug-90 | White Catfish | 2 | 2.00 |
| 31-Aug-90 | American Shad | 17 | 2.00 |
| 31-Aug-90 | Crappie | 2 | 2.00 |
| 02-Sep-90 | Bluegill | 1 | 2.00 |
| 16-Sep-90 | Bluegill | 1 | 4.00 |
| 17-Sep-90 | Bluegill | 2 | 3.00 |
| 19-Sep-90 | American Shad | 1 | 2.00 |
| 20-Sep-90 | Bluegill | 2 | 2.00 |
| 21-Sep-90 | Bluegill | 2 | 2.00 |
| 22-Sep-90 | American Shad | 4 | 2.00 |
| 22-Sep-90 | Smallmouth Bass | 1 | 3.00 |
| 23-Sep-90 | Smallmouth Bass | 3 | 3.00 |
| 24-Sep-90 | Smallmouth Bass | 1 | 3.00 |
| 25-Sep-90 | Smallmouth bass | 1 | 4.00 |
| 26-Sep-90 | American Shad | 1 | 2.00 |
| 27-Sep-90 | Blueback Herring | 1 | 1.00 |
| 28-Sep-90 | Bluegill | 1 | 2.50 |
| 02-Oct-90 | Spottail Shiner | 1 | 1.50 |
| 14-Oct-90 | Blueback Herring | 4 | 2.00 |
| 14-Oct-90 | White Catfish | 1 | 3.00 |
| 15-Oct-90 | Blueback Herring | 1 | 2.00 |
| 22-Oct-90 | Smallmouth Bass | 1 | 3.00 |
| 23-Oct-90 | Bluegill | 1 | 1.00 |
| 23-Oct-90 | Smallmouth Bass | 1 | 0.50 |
| 25-Oct-90 | Bluegill | 1 | 1.00 |
| 25-Oct-90 | Bluegill | 1 | 1.50 |
| 30-Oct-90 | White Sucker | 1 | 15.00 |
| 02-Nov-90 | American Shad | 1 | 3.00 |
| 04-Nov-90 | American Shad | 2 | 3.00 |
| 11-Nov-90 | Blueback Herring | 5 | 1.00 |
| 11-Nov-90 | Blueback Herring | 1 | 2.00 |
| 16-Nov-90 | American Shad | 2 | 4.00 |
| 29-Nov-90 | Bluegill | 1 | 2.00 |
| 29-Nov-90 | Spottail Shiner | 1 | 3.00 |
| 07-Dec-90 | Bluegill | 1 | 2.00 |
| 13-Dec-90 | Blueback Herring | 1 | 1.00 |
| | | TOTAL | 209 |

APPENDIX B

Cooling Water Flow Rates
Dexter Cogeneration Facility: 1990

# DEXTER COGENERATION FACILITY
## WATER DIVERSION PERMIT REPORTING
## WINDSOR LOCKS CANAL (DIV-89-31)
## 1990: ANNUAL REPORT

### DAILY: WATER DIVERSION (MM GALs/DAY)

| DAY | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 3.55 | 3.91 | 6.29 | 4.79 | 12.61 | 13.08 | 16.62 | 13.72 | 12.51 | 14.78 | 10.08 | 6.89 |
| 2 | 3.54 | 6.53 | 6.19 | 4.76 | 12.79 | 11.04 | 15.93 | 17.37 | 2.64 | 14.30 | 10.50 | 6.96 |
| 3 | 3.54 | 8.24 | 4.55 | 4.55 | 12.73 | 12.08 | 16.45 | 17.60 | 4.68 | 14.12 | 8.09 | 7.45 |
| 4 | 2.74 | 9.9 | 4.63 | 5.98 | 12.82 | 14.04 | 16.61 | 15.38 | 16.02 | 14.16 | 8.12 | 8.54 |
| 5 | 1.11 | 5.79 | 3.81 | 8.01 | 12.64 | 12.27 | 17.62 | 15.70 | 11.03 | 14.22 | 12.02 | 8.06 |
| 6 | 1.84 | 6.98 | 6.05 | 7.13 | 11.44 | 12.09 | 15.89 | 16.50 | 15.43 | 14.10 | 11.70 | 7.66 |
| 7 | 2.04 | 7.73 | 9.96 | 5.88 | 12.11 | 12.01 | 13.08 | 9.00 | 16.07 | 14.49 | 10.54 | 8.76 |
| 8 | 0.29 | 7.81 | 4.18 | 8.56 | 14.70 | 11.94 | 12.61 | 17.53 | 14.47 | 15.23 | 9.65 | 8.08 |
| 9 | 0.24 | 6.24 | 3.05 | 10.63 | 15.57 | 10.91 | 14.24 | 16.84 | 13.91 | 14.81 | 9.43 | 7.17 |
| 10 | 0.18 | 2.32 | 3.54 | 13.75 | 13.77 | 12.07 | 14.36 | 16.87 | 17.37 | 14.21 | 8.52 | 8.71 |
| 11 | 0.85 | 3.18 | 3.89 | 13.34 | 12.82 | 11.63 | 13.72 | 13.15 | 16.33 | 15.27 | 9.52 | 7.73 |
| 12 | 1.36 | 4.24 | 3.96 | 10.94 | 2.59 | 12.66 | 13.64 | 12.77 | 16.43 | 14.55 | 7.84 | 7.67 |
| 13 | 2.10 | 5.84 | 3.91 | 10.02 | 7.91 | 9.68 | 13.80 | 17.35 | 17.22 | 11.24 | 7.47 | 7.90 |
| 14 | 2.97 | 9.61 | 3.69 | 10.85 | 13.64 | 11.21 | 12.03 | 15.69 | 17.73 | 13.46 | 8.19 | 6.95 |
| 15 | 1.96 | 6.99 | 3.56 | 14.47 | 12.40 | 11.13 | 12.46 | 15.49 | 16.18 | 13.67 | 8.07 | 6.55 |
| 16 | 1.11 | 3.96 | 3.66 | 11.74 | 14.17 | 14.09 | 14.99 | 15.80 | 15.86 | 11.56 | 9.31 | 6.39 |
| 17 | 2.81 | 4.82 | 4.22 | 9.34 | 12.75 | 14.71 | 15.36 | 16.81 | 15.52 | 13.28 | 7.55 | 7.40 |
| 18 | 1.82 | 4.83 | 5.32 | 9.37 | 12.92 | 14.54 | 16.37 | 14.17 | 15.19 | 13.24 | 7.13 | 8.35 |
| 19 | 1.55 | 5.15 | 5.60 | 9.44 | 7.34 | 13.71 | 17.43 | 13.30 | 14.92 | 12.91 | 8.14 | 8.35 |
| 20 | 1.73 | 7.53 | 5.74 | 10.43 | 12.45 | 13.77 | 17.90 | 14.55 | 15.54 | 10.25 | 6.52 | 8.01 |
| 21 | 3.86 | 7.16 | 5.41 | 11.79 | 12.17 | 14.55 | 3.34 | 16.35 | 15.05 | 12.28 | 9.71 | 9.40 |
| 22 | 5.08 | 5.82 | 4.98 | 11.96 | 11.99 | 13.96 | 3.04 | 16.06 | 13.37 | 14.20 | 4.21 | 9.72 |
| 23 | 5.07 | 5.6 | 9.82 | 11.85 | 12.47 | 13.46 | 16.34 | 15.58 | 13.55 | 15.07 | 0.00 | 10.68 |
| 24 | 4.37 | 8.41 | 4.13 | 10.76 | 13.91 | 15.01 | 16.46 | 15.47 | 14.65 | 14.96 | 0.00 | 14.86 |
| 25 | 3.03 | 15.54 | 4.63 | 11.09 | 13.82 | 16.72 | 15.52 | 14.96 | 14.30 | 13.41 | 4.28 | 11.21 |
| 26 | 2.73 | 5.22 | 4.67 | 11.67 | 12.33 | 17.58 | 15.59 | 14.77 | 13.68 | 11.14 | 8.19 | 14.12 |
| 27 | 2.75 | 4.97 | 4.65 | 13.47 | 13.28 | 17.37 | 16.38 | 16.63 | 14.36 | 10.50 | 8.35 | 14.60 |
| 28 | 2.50 | 5.75 | 5.00 | 3.79 | 13.82 | 17.42 | 13.55 | 18.08 | 16.25 | 10.95 | 10.13 | 13.80 |
| 29 | 3.00 | | 4.86 | 4.90 | 13.11 | 16.39 | 13.39 | 19.57 | 5.46 | 10.98 | 8.97 | 12.45 |
| 30 | 3.60 | | 4.79 | 11.46 | 13.40 | 16.54 | 12.26 | 17.17 | 6.01 | 10.98 | 9.29 | 12.22 |
| 31 | 3.80 | | 4.74 | | 13.44 | | 12.86 | 16.60 | | 10.56 | | 14.33 |
| MAX | 5.08 | 15.54 | 9.96 | 14.47 | 15.57 | 17.58 | 17.90 | 19.57 | 17.73 | 15.27 | 12.02 | 14.86 |
| AVG | 2.49 | 6.43 | 4.95 | 9.56 | 12.38 | 13.59 | 14.19 | 15.70 | 13.72 | 13.19 | 8.05 | 9.39 |

### MONTHLY: WATER DIVERSION (MM GALs/MTH)

| | JAN | FEB | MAR | APR | MAY | JUNE | JULY | AUG | SEPT | OCT | NOV | DEC |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| TOT | 77.11 | 180.07 | 153.49 | 286.71 | 383.93 | 407.67 | 439.87 | 486.80 | 411.73 | 408.89 | 241.53 | 290.96 |